Geophysical Research Abstracts
Vol. 18, EGU2016-16731, 2016
EGU General Assembly 2016


# Modeling Continental Growth and Mantle Hydration in Earth's Evolution and the Impact of Life

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The evolution of planets with plate tectonics is significantly affected by several intertwined feedback cycles. On Earth, interactions between atmosphere, hydrosphere, biosphere, crust, and interior determine its present day state. We here focus on the feedback cycles including the evolutions of mantle water budget and continental crust, and investigate possible effects of the Earth's biosphere. The first feedback loop includes cycling of water into the mantle at subduction zones and outgassing at volcanic chains and mid-ocean ridges. Water is known to reduce the viscosity of mantle rock, and therefore the speed of mantle convection and plate subduction will increase with the water concentration, eventually enhancing the rates of mantle water regassing and outgassing. A second feedback loop includes the production and erosion of continental crust. Continents are formed above subduction zones, whose total length is determined by the total size of the continents. Furthermore, the total surface area of continental crust determines the amount of eroded sediments per unit time. Subducted sediments affect processes in subduction zones, eventually enhancing the production rate of new continental crust. Both feedback loops affect each other: As a wet mantle increases the speed of subduction, continental production also speeds up. On the other hand, the total length of subduction zones and the rate at which sediments are subducted (both being functions of continental coverage) affect the rate of mantle water regassing. We here present a model that includes both cycles and show how the system develops stable and unstable fixed points in a plane defined by mantle water concentration and surface of continents. We couple these feedback cycles to a parameterized thermal evolution model that reproduces present day observations. We show how Earth has been affected by these feedback cycles during its evolution, and argue that Earth's present day state regarding its mantle water budget and continental coverage might actually be unstable but with rates of change being very small. By enhancing continental weathering and erosion, and eventually the sediment transport into subduction zones, Earth's biosphere impacts both feedback cycles and might play a crucial role in regulating Earth's system and keep continental crust coverage and mantle water budget at its present day state.